ET-MODUL2-LAN/Wi-Fi User Manual

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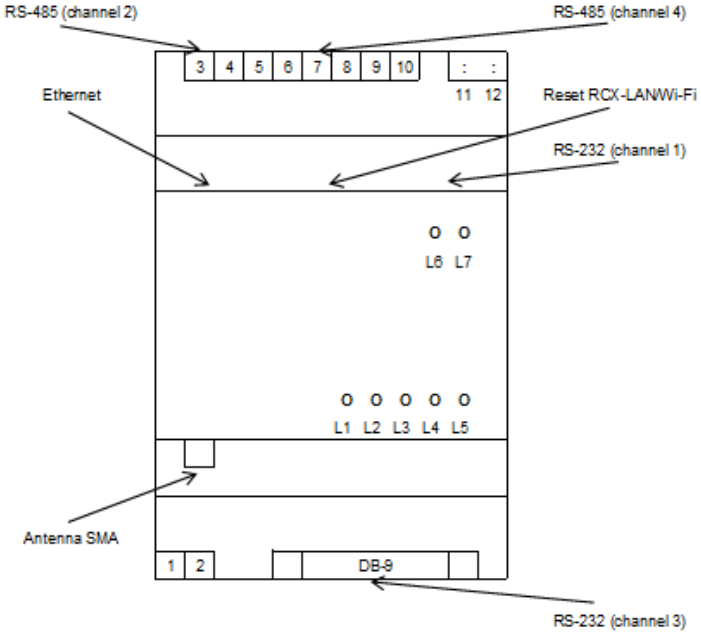
SUMMARY

1. Hardware description 2
2. Technical Specifications 2
3. Getting Started 3
3.1. Web-based Configuration Utility 3
3.2. Follow the steps below to access the Web-based configuration utility. 4
3.3. RCX-LAN/RCX-WI-FI operating modes 4
3.3.1. Modbus Gateway operating mode 4
3.3.2. Ethernet to Serial converter operating mode 5
4. Configuration 5
4.1. General Settings 5
4.2. Wi-Fi Settings 5
4.3. Wi-Fi Status 6
4.4. Routing Status 6
4.5. Password 7
4.6. Initialize 7
4.7. Reboot 7
4.8. Channel Settings 7
4.8.1. Modbus Gateway 7
4.8.2. Ethernet to Serial converter 8
5. Status LED 14
5.1. Status LED signals 14
5.1.1. Patterns that are played once in response to a certain event: 14
5.1.2. Patterns that are played repeatedly until replaced by another pattern: 15
5.1.3. When the data connection is established the following patterns are additionally displayed: 15
5.2. Channel Status LED signals 16
5.2.1. Patterns that are played repeatedly until replaced by another pattern: 16
6. Quick Initialization 16

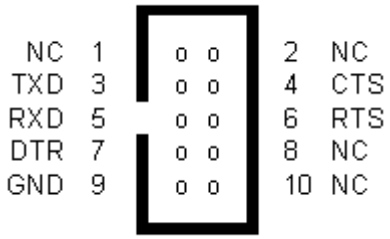
1. Hardware description

RCX-LAN/Wi-Fi is a Modbus RTU to Modbus TCP Gateway: allows you to connect devices using the Modbus RTU protocol to an Ethernet / Wi-Fi using Modbus TCP protocol.



N°	Identifier	Description
1	-	Negative supply
2	+	Positive supply
3	V0	Output supply for external devices
4	GND	Ground
5	B (-)	RS-485 TX- (channel 2)
6	A (+)	RS-485 TX+ (channel 2)
7	V0	Output supply for external devices
8	GND	Ground
9	B (-)	RS-485 TX- (channel 4)
10	A (+)	RS-485 TX+ (channel 4)
11	JP5	Load resistance RS-485 (channel 2)
12	JP3	Load resistance RS-485 (channel 4)

N°	Identifier	Descriptor
1	L1	Wi-Fi status LED
2	L2	Channel 1 status LED
3	L3	Channel 2 status LED
4	L4	Channel 3 status LED
5	L5	Channel 4 status LED
6	L6	Status GREEN LED
7	L7	Status RED LED



2. Technical Specifications

Below are the technical specifications of the RCX-LAN/Wi-Fi.

Technical Specifications:	
Serial interface channel 1	IDC 20-pin male connector Baud rate 300-115200 bps Signals: TX, RX, CTS, RTS, DSR
Serial interface channel 3	DB9 male connector Baud rate 300-115200 bps Signals: TX, RX, CTS, RTS, DSR
RS-485 serial interface channel 2 and 4	Four-pole terminal block

	Signals: TX+, TX-, V0, GND
Ethernet	10/100 Base-T Ethernet RJ45 connector Protocols IP: TCP, UDP, ARP, ICMP, DHCP
Wi-Fi	IEEE 811.2b/g WEP encryption 64/128 bit Protocols IP: TCP, UDP, ARP, ICMP, DHCP
Configuration interface	WEB configuration or provided configuration program
Security	Password
Status indicators	4 channel status indicator led, 1Wi-Fi status indicator led, 2 status led
Power	12V DC 120mA (RCX-LAN) 12V DC 155mA (RCX-Wi-Fi)
Operating Environment	Temperatura da -20 a 70 C°, umidità relativa da 5% a 95%.
Size	95X53X58 mm (3 DIN modules)
Certification	CE, EN50082, EN55011 directives

3. Getting Started

This section will show you how to configure your new RXC-LAN/RCX Wi-Fi using the web-based configuration.

3.1. Web-based Configuration Utility

Use the Web-based Configuration Utility if you wish to change the default settings or optimize the performance of the RCX-LAN/RCX-WI-FI. After you have completed the initial installation, you can access the configuration menu at any time by opening a web-browser and typing in the IP address of the RCX-LAN/RCX-WI-FI. The RCX-LAN/RCX-WI-FI's default IP address is 192.168.168.1.

3.2. Follow the steps below to access the Web-based configuration utility

1. Open a web browser;
2. Type in the **IP address** of the RCX-LAN/RCX-WI-FI (192.168.168.1);
   Note: If you have changed the default IP address assigned to the RCX-LAN/RCX-WI-FI, make sure to enter the correct IP address.
1. Leave the Password field blank;
2. Click Login.
   Note: The IP address of your pc must be in the same subnet as the RCX-LAN/RCX-WI-FI.

After logging in, the **General Settings** page will be displayed.

3.3. RCX-LAN/RCX-WI-FI operating modes

RCX-LAN/RCX-WI-FI has several modes of operation; it can be flexibly configured to operate as a Ethernet to Serial converter or a Modbus TCP to Modbus RTU Gateway. Each RCX-LAN/RCX-WI-FI's channel can be configured to operate in both modes. In particular, Channel 0 and Channel 2 are connected to RS232 serial ports, while Channel 1 and Channel 3 are connected to RS485 serial ports.
RCX-WI-FI has a Wi-Fi interface. It is through this interface that you find available Wi-Fi networks and select the one to associate with. The device is compatible with the IEEE 811.2b/g. The protection of data on Wi-Fi is provided by a 64/128 bit WEP encryption. You can also create an ad-hoc network of your own and have other stations connect to it.

3.3.1. Modbus Gateway operating mode

Follow the steps below to configure RCX-LAN/RCX-WI-FI for Modbus Gateway operating mode.

1. In the General Settings page setting the parameters of the Ethernet network, namely IP-Address, Subnet mask and Gateway IP-Address.
   Note: The IP address of your pc must be in the same subnet as the RCX-LAN/RCX-WI-FI.

2. In the Channel Settings page choose the Channel and then select the TCP/IP transport protocol and the Modbus Gateway routing mode. Also define the parameters of the serial connection, namely Port, Baud rate, Parity and Slave Address.
3. The other parameters are defined according to their needs.

Now the device is configured to operate as a Modbus gateway.
Note: For details see section 2.8.

3.3.2. Ethernet to Serial converter operating mode

Follow the steps below to configure RCX-LAN/RCX-WI-FI for Ethernet to Serial converter operating mode.

1. In the General Settings page setting the parameters of the Ethernet network, namely IP-Address, Subnet mask and Gateway IP-Address.
   Note: The IP address of your pc must be in the same subnet as the RCX-LAN/RCX-WI-FI.
2. In the Channel Settings page choose the Channel and then choose one of the first three routing mode options. Also define the parameters of the serial connection, namely Port, Baud rate, Parity and Slave Address.
3. The other parameters are defined according to their needs.

Now the device is configured to operate as a Ethernet to Serial converter.
Note: For details see section 4.8.1.

4. Configuration

This section explain in detail all the parameters of the RCX-LAN/RCX-WI-FI. The parameters are divided into configuration page.

4.1. General Settings

- Owner Name: defines the owner name identification for the RCX-LAN/RCX-WI-FI.
- Device Name: defines the device name identification for the RCX-LAN/RCX-WI-FI.
- DHCP: Choose Dynamic IP(DHCP) to obtain IP Address information automatically from server, then for the DHCP to work there must be a *DHCP server* on the network where the RCX-LAN/RCX-WI-FI is installed.
- IP-Address: 192.168.168.1 is the default WAN IP Address of the RCX-LAN/RCX-WI-FI.
- Subnet mask: 255.255.255.0 is the default subnet mask. All devices on the network must have the same subnet mask to communicate on the network.
- Gateway IP-Address: enter the IP Address of the gateway in your network. The default setting is 192.168.168.254.
- Number of serial ports: defines the number of serial ports available.

4.2. Wi-Fi Settings

The Wi-Fi Settings page is used to configure the wireless settings for the RCX-LAN/RCX-WI-FI.

- Wi-Fi: select enable if you want to switch on the Wi-Fi; the default value is disable.
- SSID: the Wireless Network Name, also called the SSID, is a unique name that identifies a network. All devices on a network must share the same wireless network name in order to communicate on

the network. If you decide to change the wireless network name from the default setting, enter your new wireless network name in this field.

- Domain: wireless communications and channels are tightly regulated in every country on Earth, and this applies to Wi-Fi networks as well. Not every one of 14 pre-defined Wi-Fi frequencies is allowed to be used in every country. It is your responsibility to set a correct "domain" for your Wi-Fi device. This is done through the Domain. Supported domains are FCC, EU, JAPAN, and "OTHER". The default value is EU: European Union.
- TX Power: the output power of the Wi-Fi hardware can be adjusted in 12 steps. The power value roughly corresponds to dB. The lowest output power is 4 and the highest power is 15. Lower power reduces the current consumption of the Wi-Fi module, but not by much. The default power value is 15.
- Authentication: select a wireless security setting. Options are None, WEP 64-bit or WEP 128-bit. Select **None** to disable encryption to across the network. Select **WEP 64bits** or **WEP 128bits** to limit communication to only those devices that share the same WEP settings.
- Password WEP: A string containing new WEP key. This is a "HEX strings", each character in the string represents one HEX digit. The string must contain 10 HEX digits for 64-bit WEP and 26 HEX digits for 128-bit WEP. Excessive digits are ignored. Missing digits are assumed to be 0.
- Ad-hoc Network: the Wi-Fi interface can create an ad-hoc network of its own and have other devices associate with you.
- Wi-Fi Channel: Channel on which the new ad-hoc network will operate.

Note: This section applies only to RCX-WI-FI.

4.3. Wi-Fi Status

This screen displays the current Wireless LAN settings on your RCX-LAN/RCX-WI-FI. The information in the dialog is updated each time Refresh button is pressed.
Wi-Fi Status dialog displays the following information:

- **Wireless.** In this section, there are information about the wireless LAN whose name appears in the SSID domain:
  - Wireless indicates the hardware Wi-Fi status: Enabled or Disabled.
  - SSID contain the name of the target network.
  - Status indicates whether the Wi-Fi interface is associated with the network or no.
  - Strength indicates the strength of the signal received from the network.
  - Authentication indicates the wireless network security setting.
  - Wireless Channel contain the number of the channel on which this network operates.
- **Wi-Fi Networks.** Wi-Fi Networks is the list of discovered wireless networks. For each network in the list, on the right of the name as reported the strength of the signal received from this network.

Note: This section applies only to RCX-WI-FI.

4.4. Routing Status

This screen displays the current LAN settings on your RCX-LAN/RCX-WI-FI and the current RCX-LAN/RCX-WI-FI operation. This feature is a very useful debugging tool that lets you determine the DS state at any moment. The information in the dialog is updated each time Refresh button is pressed.
Routing Status dialog displays the following information:

- **Current state of routing buffers.** Routing buffers are used as a temporary storage for the data being routed between the Ethernet and serial ports of the Device Servers (DS). The *routing status*

dialog reports the number of committed bytes (for serial-->Ethernet buffer), total number of bytes in each buffer ("data"), and the capacity of the buffers. Read serial-to-Ethernet data rounting topic to learn what "committed" means. Capacity information is provided because different DS models have buffers of different size.

- **Information on current data connection.** This partially doubles the data reflected by the status icons (displayed in the *device list*) and the status area of the *main window*. Additional information provided by the *routing mode dialog* includes the IP-address and the port number of the network host with which the DS has been/is/will be in a data connection. Here is what these two fields show:
  - After power-up the fields show the IP-address and port defined by the Destination IP-address setting and Destination Port Number setting;
  - If these default values are overridden by serial-side parameters and instructions (a.k.a. "modem commands") then the fields show new overriding values;
  - While the data connection is established and after it is closed (aborted) the fields show the IP-address and port of the network host with which this connection is (was) established. Notice that this may be different from the above- if the DS has accepted an incoming connection!
- **Current serial port setup.** This data may be of interest because it will not necessarily match the serial port setup defined by the serial port-related DS settings. The values of settings can be overridden by the network-side parameters (a.k.a. "on-the-fly commands"). Therefore, the *routing status dialog* can be used to verify actual current serial port setup.
- **Current state of RS232 control lines.** The state of control lines is displayed in the opposite polarity. So, if the state of RTS line (output) is shown as HIGH then this means that the DS is ready to receive the data from attached serial device.

4.5. Password

The Password page is used to change the login password and the DS Manager password.

4.6. Initialize

The Initialize is used to reset the RCX-LAN/RCX-WI-FI: the device returns to factory default.

4.7. Reboot

The Reboot is used to take effect the changes.

4.8. Channel Settings

Each RCX-LAN/RCX-WI-FI's channel can be configured to operate as a Modbus Gateway or a Ethernet to Serial converter In particular, Channel 0 and Channel 2 are connected to RS232 serial ports, while Channel 1 and Channel 3 are connected to RS485 serial ports.

4.8.1. Modbus Gateway

- Connection Timeout: connection parameter sets the timeout (in minutes) for the data connections between the VSP and the RCX-LAN/RCX-WI-FI. If no data is transmitted across the data connection (TCP or UDP) for a specified number of minutes the VSP aborts the connection. Setting connection

timeout parameter to 0 disables the feature and connection never times out. If omitted, this parameter defaults to 5 minutes.

- Transport Protocol: selects which communications protocol- TCP/IP or UDP/IP will be used by the VSP for data communications with the RCX-LAN/RCX-WI-FI. In the Gateway Modbus the communications protocol is TCP/IP.
- Routing Mode: select a mode operation of the RCX-LAN/RCX-WI-FI.
- Accept connection from: defines whether the RCX-LAN/RCX-WI-FI will accept incoming data connections from any network host (filtering disabled) or specific host only (filtering enabled).
    - When Source IP Filtering is 0 (disabled) the RCX-LAN/RCX-WI-FI will accept an incoming data connection from any network host.
    - When Source IP Filtering is 1 (enabled) the RCX-LAN/RCX-WI-FI will accept an incoming data connection only from host whose IP-address matches the one specified by current Destination IP-address.
- Port: defines the Data Port on which the RCX-LAN/RCX-WI-FI is accepting incoming data connections. For TCP communications the RCX-LAN/RCX-WI-FI accepts incoming data connections on the data port but establishes outgoing connections from a pool of ephemeral ports in the 10000-10255 range (port number is incremented with each new connection). Port 65535 is excluded from the allowable range because port 65535 is a programming port of the RCX-LAN/RCX-WI-FI-command UDP datagrams are sent to this port. Technically, this only affects UDP communications, TCP connections should still be able to use this port but the port 65535 was not allowed to be selected as the data port from the early versions of RCX-LAN/RCX-WI-FI firmware so this restriction is now preserved for "historical" reasons.
- Slave Address: defines the address of the device on Modbus serial line. The default value is 191.
- Serial Interface: serial port of the RCX-LAN/RCX-WI-FI can operate in full-duplex or half-duplex mode. In the Gateway Modbus the value is half-duplex (RS485).
- Baud rate: defines the baud rate of the serial port of the RCX-LAN/RCX-WI-FI.
- Parity: defines the parity mode of the serial port of the RCX-LAN/RCX-WI-FI. RCX-LAN/RCX-WI-FI hardware does not have an option of two stop bits. In the Gateway Modbus mode the default value is “EVEN”.
- Data bits: defines the bits/byte mode of the serial port of the RCX-LAN/RCX-WI-FI. The default value is 8 bits/byte.
- Maximum Intercharacter Delay: defines the maximum time gap between two consecutive characters recorded into the serial-to-Ethernet buffer, exceeding which will trigger a break condition. Break conditions are related to routing the data in the serial-to-Ethernet direction. Intercharacter delay can be set in 10 ms increments. Delay tracking is disabled when Maximum Intercharacter Delay is set to 0.
- Timeout RX: defines the timeout value of the serial port in Modbus Gateway mode. The value is in milliseconds. The default value is 200ms for a value of baud rate of 9600bps . For lower baud rate is preferable to use a longer timeout value.

4.8.2.Ethernet to Serial converter

- Connection Timeout: defines after how many minutes an idle connection is terminated. Setting Connection Timeout to 0 disables automatic timeouts. Setting Connection Timeout to any value in the 1-99 range enables automatic timeouts: when no packets are transferred across a connection in either direction for a corresponding number of minutes the connection is terminated. The device terminates TCP connection by sending an RST packet, while UDP "connections" are simply discarded (the other party is not informed in any way).

Connection Timeout prevents an idle ("hanged") connection from occupying the DS indefinitely thus keeping other network hosts from communicating with the DS. Note, that idle connection is defined as the one across which no *packets* are transferred for a period of time (not the one across which no *data* is transferred for a period of time). This provides a way of maintaining the connection even in the absence of data (this is known as "keepalive"). For TCP connections remote host can send empty ACK packets, for UDP " connection " remote host can send UDP datagrams of zero length. Connection Timeout is relevant even when the Connection Mode (CM) setting is 0 (immediately). In this case, when timeout comes the DS terminates an existing connection to the network host and immediately opens a new one. This can be used to "auto-repair" hanged connection in systems where permanent connection to the network host must be maintained indefinitely.

- Transport Protocol: selects which communications protocol- TCP/IP or UDP/IP will be used by the VSP for data communications with the DS. Omitting the parameter selects the UDP/IP protocol.
  For the data connection with the DS to work the same transport protocol must be selected on the DS side. This parameter has the same function as the transport protocol option of the VSP for Windows. Unless you have a specific reason why the UDP should be used (very rare!) we recommend you to stick to the TCP/IP. The TCP/IP is a "reliable delivery" protocol that makes sure that no data is lost "in transit" between the VSP and the DS. The UDP, on the contrary, does not guarantee data delivery.
- Broadcast UDP data: when Broadcast UDP is 1 (enabled), the DS will accept and route the data received in broadcast UDP datagrams, as if these packets were addressed directly to this DS. Broadcast packets must still be addressed to the correct Port Number. DS will ignore broadcast UDP packets when Broadcast UDP is 0 (disabled). This setting only allows/disallows the reception of broadcast UDP packets and has no influence over whether the DS can send out its own broadcast UDP datagrams or not. This Setting is irrelevant when current Transport Protocol (TP) is 1 (TCP), because TCP protocol cannot use broadcast packets to carry data.
- Inband Command: setting defines whether inband (TCP) programming is enabled or disabled. This Setting is irrelevant when the current Transport Protocol is 0 (UDP) because inband command passing is only possible when TCP/IP is used for data connections between the network host and the DS.
- Routing Mode: select a mode operation of the RCX-LAN/RCX-WI-FI. Routing Mode drop-down box provides four choices:
  - Server. Only incoming connections are accepted, the VSP never attempts to establish an outgoing connection to the DS. There is no restriction on which DS can connect to the VSP-connection from any IP-address will be accepted as long as the DS is connecting to the correct listening port using correct transport protocol.
  - Server/client. Both incoming and outgoing connections are allowed. Outgoing connections are established with the destination, specified in the destination section of the dialog. Exactly when the VSP attempts to establish an outgoing connection is defined by the selected connection mode. Incoming connections are accepted from any IP-address, just like with the server routing mode.
  - Client. Only outgoing connections are allowed, the VSP rejects all incoming connections.
  - Gateway Modbus.
- Destination interface: selects the network interface through which an outgoing network connection will be established (**Note**: This parameter is used only in RCX-WI-FI).
- Accept connection from: defines whether the RCX-LAN/RCX-WI-FI will accept incoming data connections from any network host (filtering disabled) or specific host only (filtering enabled).
  - When Source IP Filtering is 0 (disabled) the RCX-LAN/RCX-WI-FI will accept an incoming data connection from any network host.

- When Source IP Filtering is 1 (enabled) the RCX-LAN/RCX-WI-FI will accept an incoming data connection only from host whose IP-address matches the one specified by current Destination IP-address.

This setting is irrelevant when current Routing Mode is 2 (client) because in this mode the DS won't accept incoming connections at all.

- Port: this setting defines the Data Port on which the DS is accepting incoming data connections. For UDP communications, outgoing UDP datagrams are also sent from this port. For TCP communications the DS accepts incoming data connections on the data port but establishes outgoing connections from a pool of ephemeral ports in the 10000-10255 range (port number is incremented with each new connection). Port 65535 is excluded from the allowable range because port 65535 is a programming port of the DS- command UDP datagrams are sent to this port. Technically, this only affects UDP communications, TCP connections should still be able to use this port but the port 65535 was not allowed to be selected as the data port from the early versions of DS firmware so this restriction is now preserved for "historical" reasons. Since programming UDP datagrams can now also be sent to port 32767, this port cannot be used for UDP data communications when current Transport Protocol is 0 (UDP). The DS will allow the Port Number to be programmed to 32767 but all data sent to this port in the UDP mode will be interpreted as programming commands. Using port 32767 for TCP communications won't cause any problems. New telnet programming method uses telnet port 23 for DS programming as well. Any connection established to port 23 of the DS is interpreted by the DS as a programming connection. Therefore, this port cannot be used for data connections when the current Transport Protocol is 1(TCP).
- Connection Mode: defines under which condition the DS attempts to establish an outgoing connection (Since the DS only allows for a single data connection at a time all conditions described here only apply to a situation when no data connection is established yet) to current Destination IP-address and current Destination Port Number:
  - 0 (immediately). The DS attempts to establish an outgoing connection right after the power up (After the IP-address is obtained from the DHCP server if the DHCP setting is 1 (enabled)). The DS will also make this connection "persistent". If the connection is closed (aborted) by the network host the DS will (attempt to) establish it again. Connection timeout (defined by the Connection Timeout (CT) setting) still works in this mode: when the current connection times out the DS aborts it and immediately establishes a new connection. Such behavior "auto-repairs" hanged connections.
  - 1 (on data or command). The DS attempts to establish an outgoing connection when the first serial data is received into the serial port and committed OR when Establish Connection instruction is issued.
  - 2 (on command). The DS attempts to establish an outgoing connection only when Establish Connection instruction is issued.
  - 3 (on command or DSR=LOW). The DS attempts to establish an outgoing connection only when Establish Connection instruction is issued OR when the DSR line of the serial port is brought LOW (for at least 20ms).

  Existing connection can always be terminated by using the Close Connection instruction or Abort Connection instruction. With Connection Mode 3 (on command or DSR=LOW) it is also possible to close the connection by bringing the DSR line HI. Connection Mode is irrelevant when the current Routing Mode is 0 (server) since in this mode outgoing connections are not allowed at all.
- Destination IP-address: Defines the IP-address of the destination network host to which the DS will attempt to connect to (by default). Destination IP-address serves two purposes:
  - It defines the IP-address of the network host to which the DS will attempt to establish an outgoing data connection. Exactly when the DS will attempt to establish such a connection is

specified by the Connection Mode setting. Destination port the DS will attempt to connect to is specified by the current Destination Port Number.

- This address also specifies the only network host from which an incoming data connection will be accepted when current Source IP Filtering is 1 (enabled).

Destination IP-address is irrelevant in the following cases:

- For outgoing connection when current Routing Mode is 0 (server) because the DS does not establish outgoing connections in this mode at all.
- For incoming connections when current Routing Mode is 2 (client) because the DS does not accept any incoming connections in this mode at all or when current Source IP Filtering is 0 (disabled).

- Destination Port: Destination Port Number defines the port of the network host to which the DS will attempt to establish an outgoing connection. When the DS will attempt to establish a connection to the destination host is defined by the Connection Mode setting. Destination IP-address the DS will attempt to connect to is defined by the current Destination IP-address. Destination Port Number is irrelevant when the current Routing Mode is 0 (server) since in this mode outgoing connections are not allowed.
- Notification Destination: defines which UDP port the DS will send I/O line status change notifications to. Notification messages are generated when one of the monitored I/O lines of the DS changes its state. Which I/O lines are monitored for changes is defined by the Notification Bitmask setting. Notifications are only sent when the data connection is established and are sent to the network host with which this connection is established. Notification Destination defines which UDP port on the destination host notifications are sent to when notifications are being sent as UDP datagrams (out-of-band):
  - 0 (last know port). Notifications are sent to the UDP port from which the most recent programming UDP datagram was received. Therefore, notifications are sent after at least one such datagram is received (since the data connection is established). This option is useful when the DS has to send notifications to the PC. Port number from which PC applications are sending their programming UDP datagrams are usually ephemeral which means that they are always changing. Therefore, the DS will wait for the first programming UDP datagram to arrive.
  - 1 (port 65535). Notifications are always sent to the UDP port 65535. This option is useful when the DS is communicating with another DS. In this case the port to send notifications to is fixed and known so there is no need to wait for the programming UDP datagram to arrive.

  Notification Destination is irrelevant when the Notification Bitmask is set to is 0 because this means that no I/O lines of the DS are monitored for changes (so there will be no notifications to generate). Notification Destination is also irrelevant when notifications are being sent inside the data TCP connection itself.
- Serial Interface: serial port of the DS can operate in full-duplex or half-duplex mode. "Full-duplex" and "half-duplex" here refers exclusively to the logical operation of the DS, not to the hardware implementation of the serial port, which depends on the DS model. The setting only influences the operation of the serial port in the data routing mode. When the serial port is in the serial programming mode it is always using the half-duplex interface.
  - 0 (full-duplex). Suitable for RS232 communications. RTS (output) and CTS (input) lines are used in a "normal" way i.e. for flow control between the DS and attached serial device (when current Flow Control = 1 (enabled)), or signaling between the network host and attached serial device.
  - 1 (half-duplex). Suitable for RS485 communications. In this mode the RTS line provides direction control and the CTS line is unused. When the Ethernet-to-serial

buffer of the DS is empty (nothing to send out through the serial port) the RTS line is LOW. When there is some data to send out the RTS line is HI for as long as the data is being output. Such behavior is intended to allow the RTS line to control the direction pin of the RS485 interface ICs and RS232-to-RS485 converters.

- Flow Control: enables or disables hardware (RTS/CTS) flow control for the serial port of the DS (when in the data routing mode). When the Flow Control is 0 (disabled) the status of the CTS input is ignored and the RTS line is at LOW unless changed by the remote host. When the Flow Control is 1 (enabled) the RTS (output) and CTS (input) lines are used to regulate the flow of data across the serial cable connecting the DS to the attached serial device.
    - RTS is used to regulate the flow of data from the attached serial device to the DS. When the serial-to-Ethernet buffer of the DS has free space the RTS is LOW and the serial device is free to send the data. When the buffer becomes (almost) full the DS sets the RTS line to HI thus telling the serial device to stop sending the data. The RTS is set to HI when there are less than 20 free bytes left in the serial-to-Ethernet buffer. Additionally, the RTS line is set to HI in all cases when the serial port is closed.
    - CTS is used to regulate the flow of data from the DS to the attached serial device. As long as the DS detects LOW on its CTS input it is free to send out the data to the attached serial device. To stop the DS from sending out the data, the serial device must set the CTS line to HI. The DS won't send out the data for as long as it detects HI on its CTS input.

  Flow Control is irrelevant when the current serial interface is half-duplex.
- DTR Mode: Defines the function of the DTR line of the serial port of the DS. When the DTR Mode is 0 (idle) the DTR line is at LOW unless changed by the remote host. When the DTR Mode is 1 (connection status) the DTR (output) line of the DS reflects current connection status: the DTR line is HI when no data connection is established at the moment and LOW when there is a data connection in progress.
- Power up DTR State: Defines High or Low state of DTR pin on Startup. This setting defines the startup voltage of the DTR pin. By default, DTR is HI on startup. By changing this setting, you can have DTR set to LOW on startup.
- Baud rate: defines the baud rate of the serial port of the DS.
- Parity: defines the parity mode of the serial port of the DS. DS hardware does not have an option of two stop bits. The way around this is to set the Parity to 3 (mark). Since this means that the parity bit will always be set to 1 and since the parity bit is always transmitted in front of the stop bit, this will have the same result as having two stop bits. The DS transmits the serial data with the parity bit correctly set but does not verify correctness of parity bits in the received data. Parity is always off when the serial port is in the serial programming mode.
- Data bits: defines the bits/byte mode of the serial port of the DS (when in the data routing mode). 8 bits/byte are always used when the DS is in the serial programming mode.
- Maximum Intercharacter Delay: defines the maximum time gap between two consecutive characters recorded into the serial-to-Ethernet buffer, exceeding which will trigger a break condition. Break conditions are related to routing the data in the serial-to-Ethernet direction. See serial-to-Ethernet data routing for more information. Intercharacter delay can be set in 10 ms increments. Delay tracking is disabled when Maximum Intercharacter Delay is set to 0. Intercharacter delay is not counted when the Flow Control setting is 1 (enabled) and the DS is holding the RTS line in the HI state thus indicating to the attached serial device that the DS is not ready to receive the data. This is done to prevent the DS from generating the break conditions on time gaps caused by the DS itself.

- Soft entry into Serial programming mode: Disables or enabled serial programming mode entry through escape sequence and selects escape sequence type.
  - 0 (disabled). Serial programming mode entry through escape sequence is disabled.
  - 1 (type 1). Type 1 escape sequence consists of three consecutive escape characters (ASCII code of escape character is defined by the Escape Character setting). For the escape sequence to be recognized each of the escape characters must be preceded by a time gap of at least 100ms:
    ...previous data <--100ms--> **E.C.** <--100ms--> **E.C.** <--100ms--> **E.C.**
    If the time gap before a certain escape character exceeds 100ms then this character is considered to be a part of the escape sequence and is not recorded into the serial-to-Ethernet buffer. If the time gap before a certain escape character is less than 100ms than this character is considered to be a normal data character and is saved into the serial-to-Ethernet buffer. Additionally, escape character counter is reset and the escape sequence must be started again. The following example illustrates one important point (escape characters are shown as □). Supposing, attached serial device sends the following string:
    ABC <--100ms--> □ <--100ms--> □□**DE**

    First two escape characters is this example had correct time gap before them, so they were counted as a part of the escape sequence and not saved into the buffer. The third escape character did not have a correct time gap so it was interpreted as a data character and saved into the buffer. The following was routed to the network host:
    ABC□DE

    The side effect and the point this example illustrates is that first two escape characters were lost- they neither became a part of a successful escape sequence (because this sequence wasn't completed), nor were saved into the buffer.
  - 2 (type 2). Type 2 escape sequence is not based on any timing. Escape sequence consists of escape character (defined by the Escape Character setting) followed by any character other than escape character. To send a data character whose ASCII code matches that of escape character the serial device needs to send this character twice. This will result in a single character being saved into the serial-to-Ethernet routing buffer. It is the responsibility of the serial device to parse through the data it sends to the DS and "double" all characters whose code matches that of escape character. Example: the following sequence will make the DS enter the serial programming mode (that is, if current escape character is not 'D'):
    ABC□D

    In the sequence below two consecutive escape characters will be interpreted as data (data routed to the network host will contain only one such character- the DS will automatically eliminate the second one):
    ABC□□

    It should be noted that attached serial device should parse the data and double certain characters only for the data it sends to the DS. Reverse operation is not needed for the data being received by the serial device from the DS. Characters with ASCII code matching that of escape character arrive from the DS in a normal way- i.e. they are not "doubled".

  Notice, that serial escape sequence works even when the serial port of the DS is closed (i.e. when the Current Routing Mode is 0 (Slave) and the data connection is not established). "Closed" merely means that the serial port is not accepting any data into its serial-to-network buffer. The serial port is still listening for escape sequences even at this time. When the DS is running with the Flow Control setting set to 1 (Local) and its serial port is "closed", the RTS line of the DS will be in the disabled state (thus indicating to attached serial device that transmission is not allowed). Therefore, if the

serial device needs to transmit an escape sequence it must ignore the state of RTS signal at that time. Further behaviour of the RTS line while in serial programming mode is documented under Serial Programming.

- Escape Character: defines the ASCII code of character used in escape sequence. Which escape sequence, if any, is used is defined by the Soft Entry setting. Escape Character is irrelevant when the Soft Entry setting is 0 (disabled).
- On-the-Fly command: enables or disables on-the-fly command processing by the DS. When On-the-Fly command setting is 1 (enabled) the DS will accept on-the-fly command (network-side parameters and instructions) from the network host. When On-the-Fly command setting is 0 (disabled) the DS will reject on-the-fly command from the host. On-the-Fly command do not require prior authentication through Login command. Password protection specifically for on-the-fly command can be enabled through the On-the-Fly Password setting. On-the-Fly command provide a way of remotely controlling the serial port of the DS, hence, the name of this setting- "Remote Control".
- Password for on-the-Fly command: enables or disables password protection for on-the-fly commands. On-the-fly commands do not require prior authentication through Login command. When On-the-fly Password is 1 (enabled) and the Password setting is set (not <NULL>) the network host must supply a valid password with every Parameter command it sends. On-the-fly Password is irrelevant when the On-the-fly Commands setting is 0 (disabled) because in this case the DS doesn't accept on-the-fly commands at all.
- Notification Bitmask: defines which I/O lines of the DS are monitored for changes. When the line being monitored changes its state a Notification message is generated and sent to the network host with which the DS has an established data connection. Notification Bitmask is a byte value each bit of which disables (when 0) or enables (when 1) status change monitoring for a specific I/O line.

5. Status LED

The RCX-LAN/RCX-WI-FI has one status GREEN LED: on top of the Device. It is controlled by the internal circuitry.

5.1. Status LED signals

RCX-LAN/RCX-WI-FI feature two status LEDs -Status Red (SR) and Status Green (SG)- that display various states of device operation. RCX-LAN/RCX-WI-FI states are indicated by way of playing "LED patterns". Patterns in this topic are represented graphically in the following manner:

The pattern above means that both green and red status LEDs blink together three times. The following pattern means that red LED makes one long blink followed by two short ones:

Status LED of the RCX-LAN/RCX-WI-FI shows a number of conditions: listed below are all patterns.

5.1.1. Patterns that are played once in response to a certain event

- **Powerup pattern.** This pattern is played once when the RCX-LAN/RCX-WI-FI is switched on:

5.1.2. Patterns that are played repeatedly until replaced by another pattern

- **Ethernet port failure.** Indicates that the Ethernet port hardware is malfunctioning and network communications with the DS is not possible:

- **IP-address not obtained.** Occurs at startup when DHCP (DH) setting is 1 (enabled) and the DS has not yet obtained its IP-address from the DHCP server:

- **Data connection is closed.** This pattern means that no data connection (TCP or UDP) with any network host is currently established so the RCX-LAN/Wi-Fi is idle:

- **Sending ARP.** Displayed when the RCX-LAN/Wi-Fi is sending ARP requests to find out MAC-address of the destination network host with which the RCX-LAN/Wi-Fi is about to establish a connection:

- **TCP connection is being opened.** Indicates that TCP connection (either incoming or outgoing) is being established (i.e. SYN-SYN-ACK exchange is in progress):

- **TCP connection reset (rejected) by the network host.** Means that the TCP connection has been reset (using RST packet) by the network host to which the RCX-LAN/Wi-Fi has tried to connect:

- **Link Server login in progress.** Means that the DS has already established TCP connection to the Link Server and is now attempting to login:

- **Link Server login failed.** Means that data connection to the Link Server could be established but the server has rejected this RCX-LAN/Wi-Fi:

- **Data connection is established or being closed.** Means that data UDP "connection" or TCP connection is currently established or that TCP connection is being closed (i.e. FIN-ACK-FIN-ACK exchange is in progress):

- **Error Mode.** This pattern is played repeatedly at high speed:

- **Serial programming Mode.** This pattern is played repeatedly at slow speed:

5.1.3. When the data connection is established the following patterns are additionally displayed

- **Data is being routed, no overruns detected.** This pattern is played when the data connection is established and the data is being routed through the RCX-LAN/Wi-Fi:

- **Buffer overrun, no data routing.** This pattern is displayed when the data connection is established and the routing buffer overrun has been detected (within the present data connection):

- **Buffer overrun + data routing.** Data routing and overrun can be displayed at the same time:

5.2. Channel Status LED signals

RCX-LAN/RCX-WI-FI feature one status LED for each channel and for the Wi-Fi (this LED is used only to RCX-Wi-Fi) -Status Green (SG)- that display various states of channel operation.

5.2.1. Patterns that are played repeatedly until replaced by another pattern

- **Idle Channel.** This pattern is displayed repeatedly on the LED Lx when the Channel x is in stand-by:

- **Connection Channel.** This pattern is displayed on the LED Lx when connection is established on Channel x:

- **Wi-Fi Associated.** This pattern is displayed on the LED L1 when Wi-Fi is associated:

When Wi-Fi is not associated or disabled this LED is off.
Note: This pattern applies only to RCX-WI-FI.

6. Quick Initialization

Quick initialization is a way to completely reinitialize the DS without using any commands. This feature is handy when the DS is running in the error mode and needs to be repaired.
To quick-initialize the DS:

1. Make sure the DS is powered;
2. Press and release the Setup button to enter the serial programming mode. Status LED will play the serial programming mode pattern;
3. Wait for at least three seconds;
4. Press and hold the Setup button for at least three seconds- both status LED will be switched off and this will indicate that the initialization has been started;
5. Initialization takes about one second to complete. Initialization result will be shown by the status LED- green LED will be switched on for about 2 seconds indicating successful initialization. (If the red LED is switched on this means that the DS is malfunctioning).
6. Switch the DS off and back on again to exit the error mode if necessary.